Restoration of Abandoned Channels

Prepared for KICT, South Korea

by

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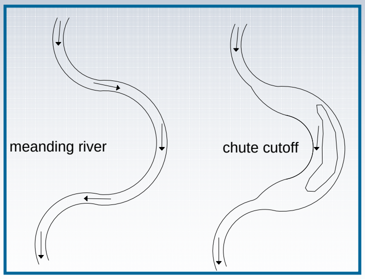
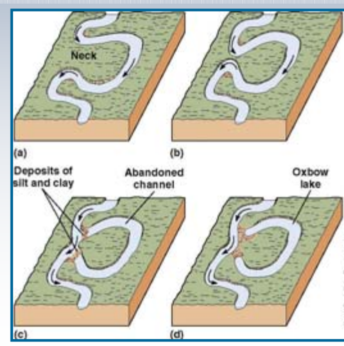
Statement of Work

1. Classification and analysis of abandoned channel restoration
2. Long-term channel changes after restoration
3. Technical reviews – *(no report required for this component)*

Abandoned Channel Processes – Natural cutoffs

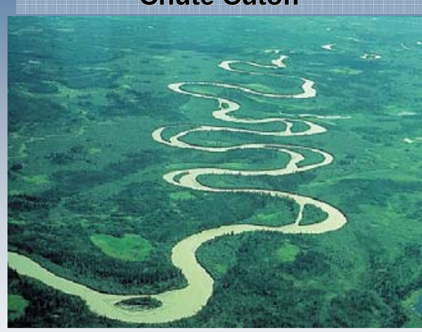
- **Chute cutoffs**
  - Occur when river cuts through the point bar, thus decreasing sinuosity
  - Channel forms a middle bar.
- **Neck cutoffs**
  - Lateral migration increases sinuosity of the channel until two bends connect
  - Sedimentation plug forms an abandoned channel called oxbow lake.





Examples of Natural Cutoffs

Chute Cutoff



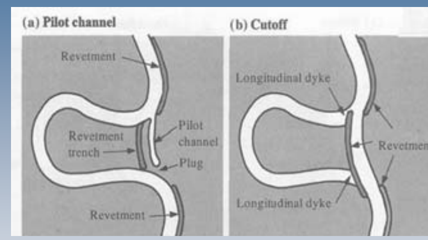
Williams River, AK
(Photo by N.D. Smith)

Neck Cutoff

Owens River, CA
(Photo by Marli Bryant Miller

Abandoned Channel Processes – Engineered Cutoffs

- Designed for Navigation and/or Flood Control
- Protect river path by constructing revetment upstream and downstream of outer side of meander
- Excavate small trench and build revetment on inside at meander neck
- Excavate pilot channel at meander neck from downstream to near upstream (1V:3H Side Slope, 15 to 60 m bottom width, 2 to 4 m below low-water reference plane)



(Julien, 2002)

Examples of Engineered Cutoffs

Earth plug separating pilot channels

Dynamite removal of earthen plug

One hour after opening cutoff

Greenville Bends
Ashbrook, Tarpley and Leland Cutoffs

http://www.mvd.usace.army.mil/mrc/Upon_There_Shoulders/Chapter12.htm

Abandoned Channel Restoration Analysis of Key Factors

Problems

- Contaminated Runoff from Non-Point Sources
  - Turbidity
  - Sediment
  - Nitrogen
  - Phosphorous
  - Dissolved Oxygen
- Reduction in Water Level
  - Dewatering
  - Lack of Connectivity to main channel

Effect

- Loss of Aquatic Habitat
  - Fish Kill
- Reduction in Recreational Value
- Hypoxic Conditions with Lake

Abandoned Channel Restoration Classification

	Type of Restoration	Benefits
Wetlands	Riparian Wetlands	Improved Water Quality, Enhance Wildlife Habitat
BMPs	Agronomics	Reduced Sediment, Nitrogen and Phosphorous
	Edge-of Field Practices	Reduced Sediment
	Stream Buffer Strips	Reduced Sediment, Nitrogen and Phosphorous
	Bank Stabilization	Reduced Sediment
Engineered Solution	Weir Construction	Increase flow interaction, improve water quality, navigation
	Dam and gate	Increase flow interaction and improve water quality
	Pump to divert flow out of lake	Improve Water quality
	Dredging	Remove organics, nutrient rich sediment and deepen lake
	Adding Water from Power Plant	Increase flow depth
	Riparian Buffer	Prevent channel migration

Best Management Practices Analysis and Evaluation Examples

- Mississippi River
  - Beasley (Edge of Field)
  - Deep Hollow (Edge of Field and Agronomics)
  - Thighman (Agronomics)

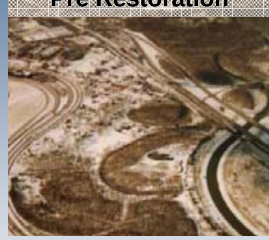
Parameters	Beasley		Deep Hollow		Thighman	
	Pre BMP	Post BMP	Pre BMP	Post BMP	Pre BMP	Post BMP
Secchi (cm)	14	17	12	25	11	15
Total Solids (mg/L)	482	265	351	143	505	334
Suspended Solids (mg/L)	429	202	289	70	405	169
Dissolved Solids (mg/L)	58	65	52	75	115	166
Nitrate (mg/L)	0.534	0.553	0.393	0.387	1.157	0.85
Ammonium-Nitrogen (mg/L)	0.123	0.139	0.189	0.116	0.168	0.224
Total Phosphorous (mg/L)	0.496	0.344	0.522	0.233	0.437	0.299
Ortho Phosphorous (mg/L)	0.032	0.049	0.019	0.046	0.018	0.044
Chlorophyll (μ/L)	16.6	118.9	24.4	61	9.9	72.2

(Knight, 2004)

Example of Wetland Restoration

Rouge River, Dearborn, Michigan

Pre Restoration

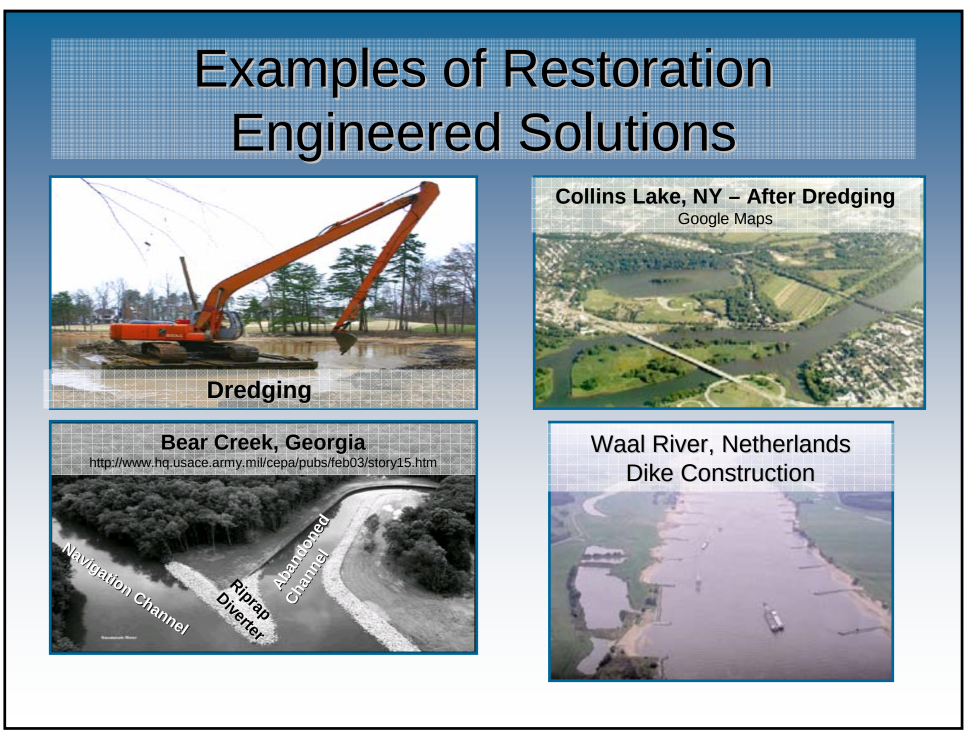


Post Restoration

Example of Cross Section

(O'Meara 2002-2003)


Examples of Restoration
Best Management Practices
Edge of Field BMP
Crop Cover
Riparian Buffers
Broad-based conservation banks
Controls Runoff and Soil Erosion
Conservation Tillage
Various websites


Examples of Restoration
Engineered Solutions
Dredging
Collins Lake, NY – After Dredging
Google Maps
Bear Creek, Georgia
http://www.hq.usace.army.mil/cepa/pubs/feb03/story15.htm
Navigation Channel
Riprap
Diverter
Abandoned
Channel
Waal River, Netherlands
Dike Construction

Long Term Studies of Abandoned Channels - Engineered Cutoff

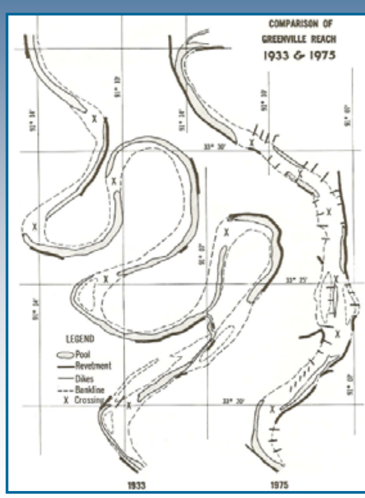
- Greenville Reach

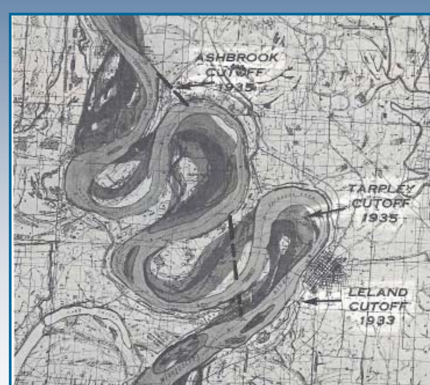
Location	Construction Date	Cutoff Length	Bend Length	Change in Slope	Initial Dimensions	Post Construction Activity
Ashbrook Cutoff	Aug-35	4,530 ft	13.3 miles	15.5 Times Steeper	13 feet to 23 feet below low water	River Widened causing formation of bars which required dredging
Tarpley Cutoff	Jan-35	13,000 ft	12.2 miles	5 Time Steeper	Cutting occurred from the downstream to upstream initially. The width was from 250 to 300 feet. The flow depth was 15 feet below low water level.	Soil was sandy and resulted in the development of bars which caused the river tendency to be braided. Dredging was needed for many years.
Leland Cutoff	Jul-33	4,600 ft	11.2 miles	13 Times Steeper	Not Available	Dredging due to braiding of river and excessive sediment transported by the upstream cutoffs.

Construction Requirements to Maintain Navigation

	Prior to 1933	1934-1974
Number of times crossings were dredge to maintain navigation	0	135
Length of revetment to hold channels	76,350 ft	137,050 ft
Length of dikes in reach	3,377 ft	61,596 ft
length of river from upstream end of construction to lower end	51 miles	24 miles

Mississippi River - Greenville Reach





HISTORIC DEVELOPMENT OF THE GREENVILLE REACH

(Winkley 1977)

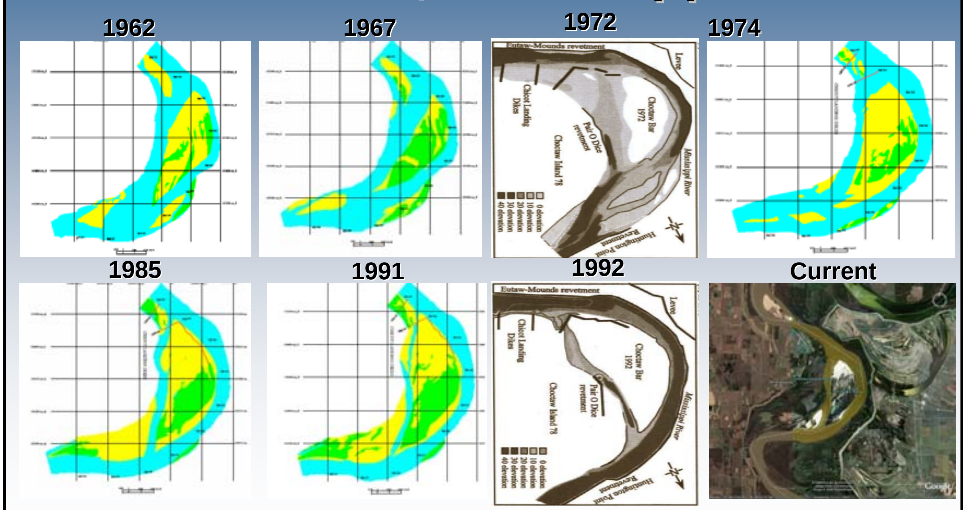
Mississippi River
Leland and Tarpley Cutoffs

(Winkley 1977)

Long Term Studies of Abandoned Channels – Chute Cutoff

- **Choctaw Bar**
  - **Stabilization the river for navigation and flood protection**
  - **Flow is divided due to a chute cutoff**
  - **1968 a stone dike system was constructed**
  - **1973 a large section of the main closure dike degraded, creating a weir, which allows significant flow in the secondary channel and caused sedimentation within the main channel requiring dredging.**
  - **Vegetation on the islands is natural and provide bar stabilization and wildlife habitat.**

Time Change
Choctaw Bar, Mississippi River



(red line = stone dikes, yellow = bare sandbar, blue = water and green = vegetation)

(USACE 1999)
(Julien 2002)

Summary

1. Classification and analysis of abandoned channel restoration projects
   - Abandoned channel processes
   - Natural and engineered cutoffs
   - Identification and analysis of key factors
   - Classification for restoration of abandoned channels
   - Type of restoration and benefits
   - Analysis and evaluation example
   - Examples of wetlands, BMP's and engineered solutions
2. Long-term channel changes after restoration
   - Review and analysis of engineered neck cutoffs
   - Review and analysis of an engineered chute cutoff

Thank You! 감사합니다!!

Red River, Minnesota

East Fork Des Moines River, Iowa

Green River, WY

Waal River, Netherlands

Murrumbidgee River, Australia

Napa River Oxbow, CA